PROCEEDINGS

OF

THE ROYAL SOCIETY.

1833–1834. No. 16.

April 10, 1834.

JOHN WILLIAM LUBBOCK, Esq., M.A., V.P. and Treasurer, in the Chair.

The Right Hon. Edwin Viscount Adare; Charles Ansell, Esq.; Felix Booth, Esq.; Lieut. Alexander Burnes, E.I.C.; Francis Corbaux, Esq.; Sir William Browne Folkes, Bart., M.P.; James William Freshfield, Esq.; John Davies Gilbert, Esq., M.A.; Edward Griffith, Esq.; Edmund Halswell, Esq., M.A.; William Charles Henry, M.D.; Robert Hudson, Esq.; Rev. William Forster Lloyd, M.A.; John Phillips, Esq.; Captain Walter Nugent Smee, E.I.C.; William Spence, Esq.; Henry Sykes Thornton, Esq., M.A.; John Warburton, M.D.; and Horace Hayman Wilson, Esq., were elected Fellows of the Society.

A paper was read, entitled, "On a General Method in Dynamics, by which the Study of the Motions of all free Systems of attracting or repelling Points is reduced to the Search and Differenciation of one central Relation, or characteristic Function." By William Rowan Hamilton, Esq., Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland. Communicated by Captain Beaufort, R.N., F.R.S.

After some introductory remarks illustrative of the scope and design of this paper, the object of which is sufficiently pointed out in its title, the author considers, 1st, the integration of the equations of motion of a system, the characteristic function of such motion, and the law of varying action; 2nd, the verification of the foregoing integrals; 3rd, the introduction of relative or polar co-ordinates, or other marks of position of a system; 4th, the separation of the relative motion of a system from the motion of its centre of gravity, the characteristic function for such relative motion, and the law of its variation; 5th, the systems of two points in general, and the characteristic function of the motion of any binary system; 6th, the undisturbed motion of a planet or comet about the sun, and the dependence of the characteristic function of elliptic or parabolic motion on the chord and the sum of the radii; 7th, the systems of three points in general, and their characteristic functions; 8th, a general method of improving an approximate expression for the characteristic function of motion of a system, in any dynamical problem; 9th, the application of the foregoing method to the case of a ternary or multiple system, with any laws of attraction or repulsion, and with one predominant mass; 10th, the rigorous transition from the theory of binary to that of multiple systems, by means of the disturbing part of the whole characteristic function, and approximate expressions for the perturbations.

A paper was also read, entitled, "Observations on the Motions of Shingle Beaches." By Henry R. Palmer, Esq., F.R.S.

The author states that the object of his inquiries is limited to the collection of such facts as may assist in establishing practical rules for controlling the motions of the beach, with a view, on the one hand, to the preservation of clear channels where such are wanted, and on the other, to the obtaining accumulations of shingles in situations where they may be useful. He considers the actions of the sea on the loose pebbles as of three kinds; the first, which he terms the *accumulative action*, heaps up or accumulates the pebbles against the shore; the second, or the *destructive action*, disturbs and breaks down the accumulations previously made; and the third, or *progressive action*, carries the pebbles forwards in a horizontal direction. The causes of these actions are referable to two kinds of forces; the one being that of the current, or the motion of the general body of the water in the ebbing and flowing of the tides; and the other that of the waves, or that undulating motion given to the water by the action of the winds upon it.

He adduces many facts which show that it is not, as is generally believed, the currents which move the pebbles along the coast, the real agent being the force of the waves, the direction of which is determined principally by that of the prevailing winds, which, on the coasts of Kent and Sussex, where the author's observations were chiefly made, is from the westward. Every breaker drives before it the loose materials which it meets, throwing them up on the inclined plane on which they rest, and in a direction corresponding generally with that of the breaker. In all cases, the finer particles descend the whole distance with the returning breaker, unless accidentally deposited in some interstice; but the larger pebbles return only a part of the distance, this distance having an inverse ratio to its magnitude. This process constitutes the accumulative action. Under other circumstances, on the contrary, depending on the quickness of succession of the breakers, pebbles of every dimension return the whole distance along which they had been carried up, and are also accompanied in their recession by other pebbles, which had been previously deposited; and this constitutes the destructive action. This latter action is also promoted by a form of coast, such as that produced by rocks, tending to confine the returning waves in particular channels, whereby, being collected into streams instead of being broken and dispersed, they acquire, on the recoil, sufficient force to carry down the pebbles, and deposit them below the general surface. The author gives examples of these effects, from what he has observed in the neighbourhood of the harbours of Folkstone, Dover and Sandgate, and along the coast as far as the bay called Sandwich Flats; accompanied by illustrative drawings.

On these principles, the author thinks it will readily appear why the various attempts hitherto made to divert the motion of the shingles to a distance from the general line of the shore, both at Dover and at Folkstone, have invariably failed; and he recommends, for the prevention of the evil of accumulation, the adoption of a more general system of management along the coast, in preference to the resorting to particular devices adapted exclusively to each particular case.

The reading of a paper, entitled, "On some Elementary Laws of Electricity." By W. Snow Harris, Esq., F.R.S.—was commenced.

April 17, 1834.

FRANCIS BAILY, Esq., Vice-President, in the Chair.

The reading of Mr. Harris's paper was resumed in continuation.

April 24, 1834.

DAVIES GILBERT, Esq., D.C.L., Vice-President, in the Chair.

The reading of Mr. Harris's paper was concluded.

For the purpose of determining several questions relative to the forces exerted by bodies in different states of electricity, the author contrived an electroscope of peculiar construction, and also an electrometer, both of which he minutely describes; and in order to obtain a unit of measure, in estimating the quantity of electrical accumulation, instead of transmitting the electricity evolved by the machine immediately from its conductor to the battery to be charged, he interposes between them a coated jar, furnished with a discharging electrometer, so that the quantity of charges that have passed through it may be estimated by the number of explosions occurring in the process of accumulation. By increasing or diminishing the distance between the discharging balls, the value of the unit may at pleasure be rendered great or small.

A series of experiments is described, showing that when a given quantity of electricity is divided among any number of perfectly similar conductors, the attractive force, as measured by the electrometer, is inversely as the square of that number; and if different quantities of electricity be communicated to the same conductor, their attractive forces are directly as the squares of those quantities.

The author observes that the electrical force exerted by one body on another is always diminished by the vicinity of a neutral body; an effect which is analogous to the operation of screens in diminishing the force of a revolving magnet on metallic disks, as noticed by him in a former paper, published in the Philosophical Transactions. It appears, thus, that there is, in all these cases, a portion of electricity, which is masked, and not appreciable by the electrometer.

The author proposes to distinguish the terms *tension* and *intensity*, as applied to electricity; expressing by the first, the actual elastic force of a given quantity, accumulated in a given space; and by the second, the action of that part which is in a state of freedom, and which is indicated by its effects on the electrometer.

Experiments are next related, which were made for the purpose of showing the incorrectness of the explanation of the above fact proposed by Mr. Singer, namely, that it depends on the electrical action of the atmosphere. In the transmission of electricity between conductors placed at a distance, the quantity required to produce a discharge is directly as the distance; and conversely, the distance is directly as the quantity. This distance will, therefore, be a measure of the tension; whereas the attractive force, as indicated by the electrometer, is a measure of intensity only. Another conclusion deduced from this train of reasoning is, that the resistance of the atmosphere to the passage of electricity is not really greater through any one discharging distance than through another, and is in no case greater than the existing atmospheric pressure; and it was found by direct experiment, that the distance through which a given accumulation of electricity could be discharged, is inversely as the density of the interposed air. When this air preserved its density unaltered, the elevation of its temperature produced no difference in its power of controlling the escape of electricity; hence it is concluded that heated air is no otherwise a conductor of electricity, than in as much as it has thereby become rarefied; but heat applied to solid conductors was found to diminish their conducting powers.

The electrical capacities of conducting bodies of different shapes was the subject of inquiry. In plates having the form of parallelograms, the relative capacities, when the areas are constant, are inversely as the sum of the length and breadth; and when this latter sum is constant, the capacity is inversely as the area. The capacity of a plane circle differs but little from that of a square having the same area; nor does it make any difference if the plates be turned into cylinders, or prisms with any number of sides; and the capacity of a sphere or cylinder is the same as that of a plane equal to it in superficial extent.

The author proceeds to investigate some laws relating to the action of electricity, when resulting from induction; and particularly that of the relation between electrical attraction and distance; adducing experiments in confirmation of the former being in the inverse duplicate ratio of the latter. The attraction actually exhibited between two equal spheres, he considers as composed of a system of parallel forces, operating in right lines between the homologous points of the opposed hemisphere. The author concludes by various observations on the transmission of electricity to bodies in vacuo, from which he infers the fallacy of all explanations of the phenomena of electrical repulsion, founded on the supposed action of the atmosphere.

The reading of a paper, entitled, "On the Generation of the Marsupial Animals; with a Description of the impregnated Uterus of the

Kangaroo." By Richard Owen, Esq., Member and Assistant Conservator of the Museum of the Royal College of Surgeons, London. Communicated by Sir Anthony Carlisle, F.R.S.—was commenced.

May 1, 1834.

BENJAMIN COLLINS BRODIE, Esq., Vice-President, in the Chair.

Mr. Owen's paper was resumed, and concluded.

The author gives a history of the opinions which have been advanced relative to the generative organs and functions of the *Marsupiata*, an extensive order of quadrupeds, including animals nourished by every variety of food, and exercising very different powers of progression, yet exhibiting a remarkable uniformity in their mode of reproduction. In all the genera included in this family, the uterus is double; in most of them the vagina is also double; and there is always a single cloacal outlet for the excrementitious substances, and the products of generation. There is a corresponding uniformity in the male organs, which are bifurcated at the extremity, and have a double groove for the transmission of the semen; and the male has not only marsupial bones, similar to those of the female, but also a muscle, similar to that which surrounds and compresses the mammary gland in the female, winding round these bones like pulleys, and acting as cremasters for the retraction and compression of the testes.

A minute description is then given of the results of the dissection of the impregnated uterus of a kangaroo, which was obtained by Mr. George Bennett, during a short residence in New South Wales, and which, together with the impregnated uteri of the Ornithorhynchus and other valuable specimens, were sent to the Museum of the Royal College of Surgeons. The membrane corresponding to the chorion, or external envelope of the fœtus, was found not to have a vascular structure, and not to adhere in any part to the surface of the uterus; neither was there any appearance of a placental or of a villous structure. It adhered internally to a vascular membrane, into which the umbilical stem of the fœtus suddenly expanded, and which terminated in a well-defined ridge, formed by the trunk of a terminal blood-vessel. The three omphalo-mesenteric, or vitulline vessels, were traced, from the umbilical cord into the abdomen, where they terminated in the usual manner; namely, the veins in the vena portæ, and the artery in the aorta. Hence it was apparent that the membrane on which they ramified, corresponded to the vascular layer of the germinal membrane, which, in oviparous animals, spreads over the yelk, or to the umbilical vessel of the embryos of ordinary mammalia. The ventricles of the heart were completely joined together, and bore the same proportions to each other as in the adult; a perfection of structure which is not observed in the embryos of ordinary mammalia at a corresponding period of developement. The lungs were equal in size to the heart, and were of a spongy texture, and full of red blood; their precocious developement, compared with that of the abdominal or digestive organs, being evidently a provision for their early or premature exercise.

From the close resemblance in the structures of the ovary and Fallopian tubes of the kanguroo with those of ordinary mammalia, and from the circumstance of the young being nourished, after birth, by a secretion from mammary glands, the author concludes that the ovulum in the former animal quits the ovisac in a condition corresponding to that in the latter class, and increases in a similar manner as it descends to the uterus. But as there is no formation of a placenta, it remains to be determined how the aeration of the fœtal blood is effected: this, however, probably takes place through the chorion, although this membrane is not vascular, to an extent sufficient for the purposes of the vital functions of a fœtus so imperfect, and whose uterine existence is of such short duration, as they are in this animal. Reasons are given, which render it probable that in the Marsupiata an allantois and umbilical arteries are developed at a later period of gestation, corresponding in this respect to the fœtal condition of the Batrachian reptiles, and corroborating the views entertained by the author, that the former family are essentially ovo-viviparous.

The author next proceeds to investigate the structure and condition of the mammary fœtus in the Marsupiata, or that stage of its existence when it is retained in the marsupial pouch, and derives its sustenance from the imbibition of milk from the mammary glands. He relates the observations which he has lately made on the fœtus of a kanguroo in the Menagerie of the Zoological Society. He ascertained that the period of uterine gestation in the animal is thirty-nine days, and examined the fœtus a few hours after it had fixed itself to the nipple in the abdominal pouch, and when it was not much above an inch in length, and resembled an earth-worm, both in the colour and the semi-transparency of its integument. Four days afterwards, he detached it from the nipple, and observed that although it moved its limbs freely, it was unable to regain its former situation. The parent endeavoured to replace it by introducing its head into the pouch, which it held open with its fore paws; but these efforts were ineffectual, and the next day the fœtus had disappeared, having, probably, been destroyed by the mother.

The last section of the paper is occupied by an inquiry into the structure and analogies of the female generative organs of the Marsupiata. These are traced throughout the successive orders of mammalia, to their connexions with various tribes of birds and reptiles, and is concluded by a disquisition on the final purposes of marsupial generation, and its relations to the other modes by which the continuance of the race is accomplished, in the more elevated orders of animals, and which appear to have reference to the greater expansion and perfection of the brain, and the greater developement of the intellectual faculties.

A paper was then read, entitled, "On a new Law of Combustion." By Charles J. B. Williams, M.D. Communicated by W. G. Maton, M.D., F.R.S.

The principal object of this paper is to prove that most combustible bodies undergo a kind of combustion, attended with light and heat, at a temperature considerably below that usually assigned as their point of ignition. This fact has been already noticed with regard to phosphorus and sulphur; and the pale blue flame produced in the vapour of ether by a hot palladium or platina wire, before the wire itself becomes vividly ignited, is another instance of the same general law, which the author finds applicable to all compound, and a few of the simple inflammable bodies. Of these he gives a variety of examples among oleaginous, resinous, and carbonaceous products, both animal and vegetable, which, when thrown on a hot iron, exhibit a pale and faintly luminous flame. Those on the other hand which are very volatile, such as camphor, the essential oils, ether and alcohol, rise in vapour before they reach the temperature necessary for their combustion; but they may be made to exhibit the same phenomena, by directing their vapour against a body heated below redness. The contact of pure oxygen gas immediately heightens the intensity of the light and heat evolved on these occasions, and excites them into a more decided and vivid combustion.

The author next adverts to the nature of the products of this low form of combustion, which, in organic substances, appear to him to form an intermediate link between those of open combustion, and those of fermentation and putrefaction. He considers the phenomena he has described as confirming the truth of a law he formerly announced, namely, that "the evolution of heat during chemical change is, *cæteris paribus*, proportionate to the degree of change from isolation, or weak combination, towards firm and simple union." He thinks they will afford an explanation of many cases of spontaneous combustion, which have hitherto been involved in mystery; such as that of porous combustible matters, as oily cotton, tow, or wool, when accumulated in considerable quantities, in places protected from cooling, or where air has limited access; and also of heaps of coal or charcoal, of pyrophori and pyrites; and the same principles may perhaps also account for the phenomena of the spontaneous combustion of the human body which are on record.

May 8th, 1834.

FRANCIS BAILY, Esq., Vice-President, in the Chair.

A paper was read, entitled, "On the Connexion between Refracted and Diffracted Light." By Paul Cooper, Esq. Communicated by J. G. Children, Esq., Sec. R.S.

The purport of the present paper, as stated by the author, is to connect the phenomena of the dispersion of light arising from refraction, with that consequent upon diffraction, by showing, 1st, "that white refracted light is formed by the superposition of fringes of colours, or rays of light uniformly refracted, which compensate each other in succession; 2nd, that diffracted white light is formed by the superposition of fringes which are not uniformly refracted, but which recede from it so gradually, as not to prevent the same mutual compensation, although it is distinguished by other appearances; and 3rd, that the purity of the colour of the light, in both cases, depends upon its continuity, any interruption of which, although the different portions into which it may be separated are white at the moment the division takes place, produces colours in its further progress, because each portion carries with it the difference of direction required for their developement."

A paper was also read, entitled, "Observations on the Reciprocal Influence which Magnetic Needles exercise over each other, when placed at a given distance within their respective Spheres of Action, at different positions on the Earth; with Tables of numerical Results obtained at separate Stations. Also a method of discovering where certain local influences are acting on the Needle, from which may be obtained a proportional correction to be applied to Magnetic Observations in general." By Edward J. Johnson, Esq., Commander R.N. Communicated by Francis Beaufort, Esq., Capt. R.N., F.R.S.

The author, considering it probable that two or more magnetic needles freely suspended at a certain distance in given positions with respect to each other, would develope certain proportionate deflections determined by their position on the earth, made a set of experiments, with a few common compass needles, at Yarmouth, London, and Clifton, which so far confirmed the truth of his conjecture, as to induce him to fix on stations at a greater distance from one another, and to multiply his observations; ascertaining, from time to time, that the magnetic powers of his apparatus had undergone no material change. The results of these observations are given in a tabular form.

The author conceives that comparative observations of the amount of deflection produced by one magnet on another, placed in various situations, relative to the meridian, on an horizontal plane, will afford the means of determining the peculiar local influences of the particular situation in which the experiment is made, as distinguished from the general magnetic influence; because the former will act unequally on each magnet, while the latter acts equally on all.

N.B. A mistake occurs in the dates of the Meetings at pages 268 and 271 of the Proceedings, (in No. 15,) 1833 being printed instead of 1834.